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**DEPARTMENT OF THE NAVY**  
OFFICE OF THE CHIEF OF NAVAL OPERATIONS  
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

OPNAVINST 9072.2  
OP-03C  
Ser 09/7U300716  
12 January 1987

**OPNAV INSTRUCTION 9072.2**

**Subj: SHOCK HARDENING OF SURFACE SHIPS**

**Ref:** (a) DOD Instruction 4245.4 of 2 Sep 1983 (NOTAL)  
(b) OPNAVINST 3401.3  
(c) NAVSEA 0908-LP-000-3010  
(d) MIL-S-901  
(e) OPNAVINST 5420.2N (NOTAL)  
(f) OPNAVINST 5000.42C (NOTAL)

**Encl:** (1) Surface Ship Shock Hardening Criteria  
(2) Surface Ship Shock Test and Shock Trial Requirements

1. Purpose. To establish policy and assign responsibility for shock hardening of surface ships.

2. Cancellation. OPNAVINST C9072.1 and Report Control Symbols OPNAV 9072-1 and OPNAV 9072-2.

3. Background. References (a) and (b) require that nuclear hardness be included in ship design and acquisition, that hardness levels be validated where possible and that nuclear hardness be maintained through a comprehensive program of maintenance and surveillance. References (c) and (d) establish the Navy's basic criteria for shock design and shock qualification testing of mission-essential surface ship systems. The Surface Ship Survivability (SSS) Program addresses, in part, vital shock hardening initiatives to enhance the Navy's mission capability and operational effectiveness posture.

4. Policy. In support of the Chief of Naval Operation's (CNO's) commitment to progress in ship platform survivability, all Navy surface commands shall ensure shock hardness is inherent in ship and equipment design, is validated by ship shock trials, and is effectively maintained. Consistent with required military characteristics, shock hardness shall be designed and engineered into surface ship platforms, aircraft/shipboard interface systems and related equipment. For new starts, shock hardening considerations shall be introduced in the Concept Formulation Phase, be included as an element in Top Level Requirements (TLRs) and shall be maintained throughout the life of the platform. Overhaul and modernization programs shall employ the most rigorous practical application of shock hardening improvements, particularly in cases where known hardness deficiencies exist. Where shock hardening is required the designated procuring activity shall ensure that the development, procurement and life cycle support requirements for affected systems/equipments fully reflect this policy.

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5. Applicability and Scope. Applies to new construction and operational surface ships, including installed and stowed systems/equipment, and to shipboard items which are designed and furnished by other U.S. Government agencies or by foreign suppliers. Shock hardening initiatives encompass the development and installation of system improvements to prevent or minimize the broad degrading effects of shock on mission performance. Application of shock hardening techniques shall be consistent with CNO's operational readiness and warfighting sustainability goals. Ship types and functions that typically require shock hardening and basic hardening criteria are identified in enclosure (1).

6. Validation Testing. The shock resistance of mission-essential items shall be validated by shock testing per reference (d), size and weight of the item permitting. Validation of total ship hardness including onboard mission-essential items (installed and/or stowed configurations) shall be accomplished by ship shock trials. Details pertinent to ship selection and pre-trial and post-trial shock planning, reporting and funding requirements are contained in enclosure (2).

7. Responsibilities

a. Chair, Ship Characteristics and Improvement Board (SCIB) is the CNO's Executive Agent for implementing SSS initiatives which include shock hardening provisions on surface ships. In addition to the SCIB responsibilities set forth in reference (e), and in conjunction with the warfare sponsors, the Chair shall:

(1) Provide continuous coordination, direction, management focus, and control to ensure effective implementation of surface ship shock hardening requirements.

(2) Ensure planning, programming, staffing, and budgeting to support engineering development, procurement and installation of corrective shock modifications.

(3) Issue directives to ensure surface ship shock hardening implementation, accountability and funding across warfare/platform sponsors and Fleet commands, including the need to address shock hardening considerations in requirements documents.

b. Commander, Naval Sea Systems Command (COMNAVSEASYS COM) exercises primary responsibility for surface ship hardening and shall:

(1) Serve as the Navy's central focus for implementing operational requirements developed by the SCIB and providing appropriate guidance pertaining to Navy shock criteria. Provide Navy coordination of interface shock requirements (see para. 3c of enclosure (1)) and define shock interface criteria and estimated shock loading characteristics applicable to specific procurements.

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(2) Take action on all requests for shock qualification approval.

(3) Develop and implement a program of shock hardness maintenance and surveillance for ships and shipboard equipment in compliance with reference (b).

(4) During the first quarter of each fiscal year, submit the proposed allocation of ship types and classes to be tested during the next two fiscal years to CNO for approval.

(5) Identify funding requirements and submit budget requests for all funding required for ship shock trials including pre-trials preparation and post-trials repair.

(6) Develop a follow-up action plan for each ship which will undergo shock trials and submit semiannual reports on the progress of execution of each follow-up action plan.

(7) Develop and issue detailed plans for ship shock trials, direct all ship shock trials and promptly report the results of these trials to CNO, Fleet Commanders-in-Chief, and other cognizant or participating commands.

(8) Provide and install all special equipment and material required for shock trials including instrumentation, explosives and containers for explosives.

(9) Continue to develop or update ship shock test and trial procedures, including those for routine low-level single-shot tests of shock hardened ships, under Ship Hardening Program sponsorship.

(10) Take final approval action on all requests for waiver of Navy shock qualification requirements for all equipment to be installed aboard ship. This requirement is applicable to equipment procured by other SYSCOMS as well as COMNAVSEASYSKOM. Approval of shock qualification waivers shall not be delegated below COMNAVSEASYSKOM or the Chief Engineer.

c. Commanders, Systems Commands (SYSCOMS) shall:

(1) Coordinate preparation of development and purchase specification shock requirements with COMNAVSEASYSKOM, and include interface shock requirements developed by COMNAVSEASYSKOM in development specifications.

(2) Appoint or maintain a SYSCOM Shock Coordinator who shall function as the responsible single point of contact for SYSCOM shock hardening matters.

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(3) Forward requests for shock qualification approval to COMNAVSEASYSCOM for approval action.

(4) Evaluate shock waiver requests and forward to COMNAVSEASYSCOM for approval action.

d. Fleet Commanders-in-Chief. Fleet Commanders-in-Chief shall:

(1) Make ships available for approved shock tests or trials.

(2) Provide necessary Fleet support of approved ship shock test or trial operations.

e. Designated Program/Project Offices are responsible for the acquisition of ship and/or shipborne equipment/systems in strict conformance with required operational capabilities and mission requirements issued by CNO.

(1) The cognizant Ship Acquisition Project Manager(s) (SHAPM) is responsible for approving the applicable shock grade of equipment/systems installed integral to or stowed onboard the ship based upon stated CNO requirements, such as TLRs. The SHAPM shall consider the technical guidance provided by the cognizant SYSCOM Program/Project Offices accordingly.

(a) The SHAPM shall issue appropriate shock requirements via contractual requirements and Ship Project Directive System documentation to contractors and Participating Managers (PARMs) and enforce conformance.

(b) The SHAPM shall ensure that the issue of shock is addressed consistently in all applicable program documentation and provide the required support in the conduct of ship shock trials, with pre-trial preparations and post-trial follow-up actions.

(2) The Cognizant Program/Project Manager(s) (PM) and Life Cycle Manager(s) are responsible for ensuring that the acquired equipment/system is capable of requisite performance in projected operational environments including shock.

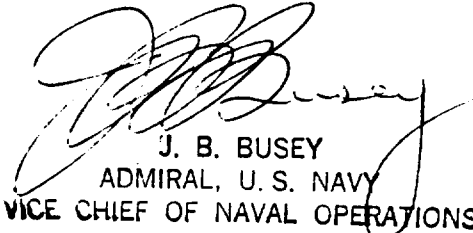
(a) The PM shall conform with requirements for shock resistance imposed by cognizant SHAPM(s) and/or COMNAVSEASYSCOM.

(b) When immediate conformance with requirements imposed by cognizant SHAPM(s) and/or COMNAVSEASYSCOM is not feasible, the PM in conjunction with the appropriate platform sponsor shall initiate a request for waiver and propose a plan for earliest attainment of requisite capability.

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f. Warfare System Architects and Engineers (WSA&E) assigned to COMSPAWARSYSCOM are responsible for converting TLRs into specific shock hardening requirements in accordance with the battle force system engineering approach specified by reference (f). The WSA&E shall participate in or review shock qualification tests and waivers to the extent necessary to verify and control performance requirements.

8. Report. The reporting requirements contained in paragraph 7b(7) and in paragraph 4 of enclosure (2) are assigned symbol OPNAV 9072-3 and are approved for three years from the date of this directive.



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SURFACE SHIP SHOCK HARDENING CRITERIA

1. Applicability to Ships, Naval Aircraft, Boats, and Craft

a. Ships. Shock hardening is required for all surface ships which must be capable of operating in the combat shock environment. These include all fighting ships, amphibious, and mineforce ships, and other ships which are intended to remain operational in wartime in combat zones. The CNO may require shock hardening of other ships on a case basis.

b. Naval Aircraft. Aircraft must be capable of resisting shock loads in the stowed configuration and mission-essential aircraft-mounted items such as auxiliary fuel tanks and avionic pods which are stowed aboard air capable ships must be shock resistant in their shipboard stowed configurations.

c. Boats and Craft. Shock hardening requirements will be determined by CNO on a case basis for air cushion vehicles, hydrofoils, surface effect ships, small boats, and similar craft. Landing craft which are stowed in the well deck of shock hardened ships may, at the discretion of CNO, be required to withstand shock in the stowed configuration.

2. Applicability to Shipboard Systems. Shock hardening criteria are applicable to items which are required for performance or direct and vital support of the following mission-essential functions aboard shock hardened ships:

- (1) Ship control and propulsion
- (2) Command-and-Control
- (3) Navigation
- (4) Communications
- (5) Surface, air, and underwater surveillance
- (6) Countermeasures
- (7) Launching, retrieving, fueling, defueling, rearming, and handling of aircraft and surface small craft
- (8) Essential checkout and maintenance of aircraft and ordnance
- (9) Fire control, firing or launching, and guidance of missiles and other weapons
- (10) Stowage, handling, and reloading of weapons
- (11) Replenishment at sea (stowed configuration)
- (12) Minehunting and sweeping
- (13) Transporting and landing troops and combat payload (assault ships)
- (14) Casualty and damage control
- (15) Collective Protection Systems (CPS)
- (16) Other capabilities as deemed necessary for the specific ship class by CNO

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3. Shock Hardening Criteria

a. Acceptance of mission-essential items for installation aboard shock hardened ships shall be based upon pre-acceptance shock testing per MIL-S-901 if the size and weight of the item permit such testing. Non-shock testable items and foundations for shock resistant items shall be designed for shock per NAVSEA 0908-LP-000-3010 "Shock Design Criteria for Surface Ships."

b. Expendable ordnance shall satisfy shock requirements while in the stowed configuration and shall be capable of performing their intended function after launch. Weapon handling and loading equipment which is part of the firing cycle and has a specified reload/firing rate shall meet shock hardening requirements in both the stowed and operating configurations. Other weapon handling and loading equipment, such as fork-lift trucks, aero-skids, rolling deck equipment, and weapon elevators, shall meet shock requirements in the stowed condition.

c. The capability of items to withstand shock aboard ship is dependent in part upon the design and arrangement of interfacing shipboard stowage systems, missile magazines, foundations, or other supporting structure. The intended shipboard supporting structure must be defined in development specifications in sufficient detail to ensure that subsequent shock qualification actions will reflect the planned shipboard structural interface. Similarly, ship design specifications must include previously established interface requirements. Interface shock requirements will be defined and coordinated by COMNAVSEASYSKOM.

d. The as-built shock resistance of Navy ships shall not be degraded as a result of post-delivery modifications. Shock hardening requirements applicable to overhaul of operational ships are defined by NAVSEA S9AA0-AB-GOS-010/GSO "General Specifications for Overhaul of Surface Ships."

e. The shock qualification standards of this instruction apply without change to mission-essential items such as missiles or warheads which are designed and furnished by other U.S. agencies or by foreign suppliers. To the extent that it is not feasible to modify the item to suit these shock standards, the shipboard mounting will be designed to appropriately mitigate the applied shock loadings. Such items, with their shock mitigation systems, if any, shall be subject to pre-acceptance shock testing or design in accordance with paragraph 3a above.

f. Detailed criteria for shock hardening of ships shall be as established by COMNAVSEASYSKOM.

SURFACE SHIP SHOCK TEST AND SHOCK TRIAL REQUIREMENTS

1. Ship Shock Tests vs. Ship Shock Trials

a. For purposes of this instruction, a ship shock "test" is a technically oriented exercise intended to define shock survivability problems in scientific or engineering terms. A shock "test" may also provide technical information needed to advance shock hardening state-of-the-art. Shock tests are managed by cognizant Fleet commands or Navy laboratories.

b. Shock "trials" of ships are intended to validate the ability of new construction ships to carry out their assigned missions in the combat shock environment. Trial preparations shall center upon taking the actions necessary to eliminate potential shock deficiencies. Shock trials are managed by the cognizant Ship Acquisition Project Manager or cognizant Ship Logistics Manager.

2. Ship Selection for Tests or Trials

a. The lead ship of each shock hardened class delivered from new construction shall be subject to shock trials as part of the post-delivery trials and test program.

b. Non-shock hardened surface ships, boats, or craft, or ships delivered from conversion or modernization may be subject to shock trials at the discretion of CNO. COMNAVSEASYS COM will recommend shock trials based on demonstrated military gain of such shock trials.

c. Landing craft may, at the discretion of CNO, be subject to ship shock trials to demonstrate their ability to withstand shock while stowed in the well deck of shock hardened amphibious ships.

d. Additional shock trials of ships of the same class will be conducted at the discretion of CNO when necessary to validate action taken to correct deficiencies revealed by shock trials of the lead ship, to validate new systems not represented during the original trials, to validate the work of different shipbuilders, or for similar reasons.

e. Every shock hardened ship shall be considered a potential candidate for low-level, single-shot shock tests. Such tests will be performed for crew training purposes and to identify any shock-related quality assurance and maintenance deficiencies. These tests will be performed by Fleet units following procedures developed by COMNAVSEASYS COM.



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3. Pre-Trials Requirements. To minimize the impact on ship and Fleet operations and to ensure that the desired benefits of shock trials are realized, the following pre-trials requirements are established

a. Shock Trials Preparation. When possible, testing of high value ships (i.e., major combatants generally larger than a destroyer) or ships of advanced design (e.g., Hydrofoil, Surface Effect Ship) shall be preceded by shock trials of a ship of an earlier design which is the most similar to the high value or advanced design ship. Preparation for all shock trials shall include a comprehensive readiness review consisting of shock qualification surveys, ship inspections, and predictive analyses. Shock deficiencies shall be documented and corrected prior to conducting shock trials except where this requirement is specifically waived by COMNAVSEASCOM. In addition, shock awareness training and system restoration training shall be provided to the ship prior to shock trials.

b. Follow-Up Action Plan. Planning for conduct for ship shock trials must include development of a formal plan for tasking corrective follow-up action on the results of such trials. This plan must be approved by CNO in advance of shock trials and shall provide for repair of shock trials damage, development of engineering fixes, and also shall provide for prompt accomplishment of corrective shock hardening on a class-wide basis (and Fleet-wide basis, if necessary) to eliminate the shock deficiencies revealed by the shock trials. The follow-up action plan shall specifically identify funds reserved or budgeted to accomplish the anticipated follow-up actions, and shall specifically identify responsibilities for taking this action with respect to both Government-Furnished Equipment (GFE), Government-Specified Equipment (GSE), and shipbuilder-furnished items.

4. Post-Trial Requirements. Situation Reports on the progress of execution of the follow-up action plan will be submitted semiannually to CNO. It is intended that all shock hardening modifications, including those to GFE and GSE, will be accomplished on a class-wide basis while the affected ships are within the Ship Construction, Navy (SCN) funding envelope. In cases where the affected ships are outside the SCN envelope, or in cases where lead time to develop improved designs prevents accomplishment of corrective action prior to the end of SCN cutoff, corrective action requirements shall be identified for accomplishment under the Fleet Modernization Program. Resulting Title D and Title K alternations shall be budgeted for following existing procedures.